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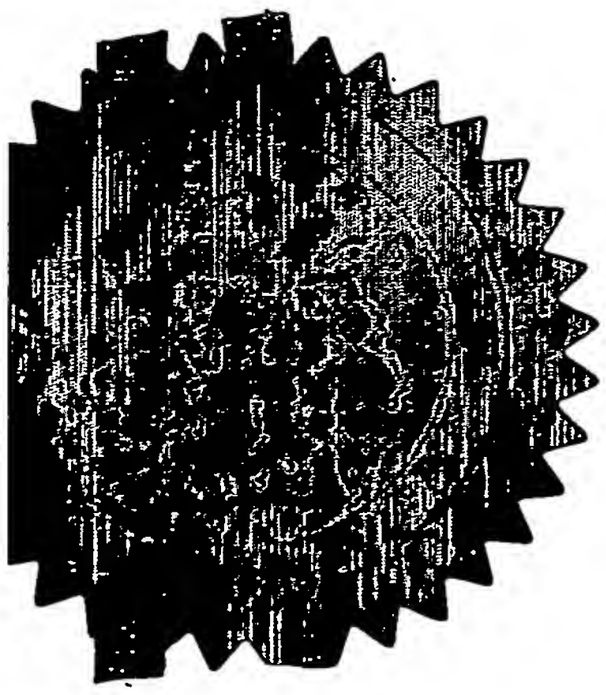

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Dated 15 December 2004

Patents Form 1/77

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The Patent Office

Cardiff Road
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1. Your reference P69630GB00

2. Patent application number *(The Patent Office will fill this part in)* 0401765.3

27 JAN 2004

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

MARKETING WORKS INTERNATIONAL LIMITED
58 HOWARD STREET
BELFAST
BT1 6PJ

Patents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation BELFAST2000003

4. Title of the invention

LENTICULAR IMAGE DISPLAY APPARATUS

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

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Patents ADP number *(if you know it)* 8676116001

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Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*
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Continuation sheets of this form	0
Description	25
Claim(s)	0
Abstract	0
Drawing(s)	16 x 16 SD

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Request for a preliminary examination and search (Patents Form 9/77)	0
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11. I/We request the grant of a patent on the basis of this application.

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12. Name, daytime telephone number and e-mail address, if any, of person to contact in the United Kingdom ALAN WALLACE 02890 236000

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LENTICULAR IMAGE DISPLAY APPARATUS

The present invention relates to a lenticular image display apparatus.

A lenticular image is a device which allows a viewer to view two or more different images depending on the angle at which the viewer observes the device. A lenticular image typically comprises a plurality of parallely disposed elongate lenses placed over interleaved slices of the images to be viewed. The device can be used to show entirely different images or can be used to generate an impression of motion.

The quality of the viewed images depends on the alignment and contact between the image slices and the lenses. To ensure good alignment and good contact, a sheet carrying the interleaved image slices is usually permanently fixed to the flat reverse face of a sheet carrying the lenses. As a result, the viewer is typically required to travel past the lenticular image in order to view the different images available.

Such lenticular images suffer from a number of disadvantages, including: the lenses are costly; the interleaved images are costly; correctly fixing the image sheet to the lens sheet is difficult; the lenses are not reusable; the images are not reusable; and the images are not clearly viewed from a head-on perspective.

Display apparatus are known in which the image sheet and the lens sheet are separate and in which the image sheet is actuated with respect to the lens sheet so that a static viewer may view each of the available images. However, such apparatus tend to be relatively complex, and therefore costly, and tend to suffer from poor alignment and poor contact between the lens sheet and the image sheet.

In view of these problems, various lenticular image apparatus normally have a limited appeal to businesses such as advertisers.

It would be desirable, therefore, to provide a lenticular image display apparatus which mitigates at least some of the problems associated with the prior art.

Accordingly, a first aspect of the present invention provides an apparatus for displaying a lenticular image comprised of a lenticular image sheet and a lenticular lens sheet, the apparatus comprising a housing adapted to receive the lenticular image sheet and lenticular lens sheet so as to allow relative sliding movement between the two in a direction substantially perpendicular to the longitudinal axes of lenses on the lens sheet, wherein the housing includes means for retaining one of said lenticular image sheet and said lenticular lens sheet in a fixed position relative to the housing, the apparatus further including means for actuating the other of said lenticular image sheet and

said lenticular lens sheet in said direction of movement.

In the preferred embodiment, the image sheet is fixed with respect of the housing and the lens sheet is actuated by said actuating means.

Preferably, the image sheet and the lens sheet are sandwiched between first and second plates. At least the plate which is adjacent the lens sheet is at least partially formed from a transparent material.

Preferably, the housing comprises a first frame and a second frame operable between an open and a closed state, at least one of the claims defining a display window. More preferably, the frames are hingedly connected to one another.

Preferably, the housing, and more particularly the frames, are arranged to grip the lens sheet and the image sheet (and, when present, the first and second plates) in order to maintain a close or intimate relationship between the lens sheet and the image sheet.

To this end, the frames are conveniently shaped to define a recess around the periphery of the or each display window, the recess being shaped and dimensioned to receive the periphery of the lens sheet and image sheet assembly. Preferably, a flexible padding component is provided in said recess to ensure that the

housing maintains an adequate grip on the lens sheet and image sheet assembly.

In the preferred embodiment, the actuating means comprises a rotary cam and at least one cam follower arranged to impart reciprocating movement to the lens sheet (or to the image sheet, as applicable).

A second aspect of the invention provides a lenticular image display apparatus comprising the apparatus of the first aspect of the invention and said image sheet and lens sheet assembly.

Further advantageous aspects of the invention will become apparent to those ordinarily skilled in the art upon review of the following description of a specific embodiment of the invention and with reference to the accompanying drawings.

An embodiment of the invention is now described by way of example and with reference to the accompanying drawings in which like numerals are used to indicate like parts and in which:

Figure 1 is a schematic view of a lenticular image;

Figure 2 is a perspective view of a lenticular image display apparatus embodying the invention;

Figure 3 is a perspective view of a lenticular image display assembly for housing within the apparatus of Figure 2;

Figure 4 is a side section view of the apparatus of Figure 1 housing the assembly of Figure 2;

Figure 5 illustrates a drive mechanism suitable for use with the apparatus of Figure 2;

Figure 6 is a perspective view of a slipper bearing;

Figure 7 is a perspective view of part of the apparatus of Figure 2 including a tilt adjustment mechanism;

Figures 8 to 11 each illustrate a respective alternative embodiment of a display apparatus according to the invention;

Figure 12 is a front view of part of a still further embodiment of a display apparatus according to the invention;

Figure 13 is a close up view of part of a drive mechanism used in the embodiment of Figure 12;

Figure 14 is a perspective view of the mechanism of Figure 13;

Figure 15 is an side view of the mechanism of Figures 13 and 14; and

Figure 16 is an end view of part of the apparatus of Figure 12.

Referring now to Figure 1 of the drawings, there is shown a lenticular image, generally indicated at 10. The lenticular image 10 comprises a sheet 12 of lenticular material and an image sheet or substrate 14. The lenticular sheet 12 comprises a plurality of parallely disposed elongate lenses 16, or lenticules, each having their respective axis of curvature parallel with their longitudinal axis. Hence, the obverse face 13 of the lenticular, or lens, sheet 12 is ribbed or grooved, with the reverse face 15 is substantially flat.

The image substrate 14, which may for example comprise paper, carries interleaved image slices or portions (not shown) which are substantially parallely disposed with respect to the longitudinal axes of the lenses 16. Each image slice comprises a portion of a whole image and the image slices of one whole image are interleaved with the image slices of another whole image on the substrate 14. The image slices are aligned with the lenses 16 so that a viewer (indicated schematically at 18) sees a particular set of image slices (and therefore a particular whole image) depending on the angle at which he views the lenticular image 10. Typically, the image sheet 14 is fixed, e.g. glued, to the reverse face 15 of the lens sheet 12. In so doing, it is important not only that the image slices are correctly aligned with the lenses 16, but also that

they are in close or intimate contact with the lenses 16. The image slices may equally be printed directly on the reverse face (not visible) of the sheet 12 in conventional manner.

The whole images carried on the substrate 14 can be viewed sequentially upon relative pivotable or rotational movement between the viewer 18 and the lenticular image 10. The images viewed may be entirely different or may be incremental versions of the same image to give an impression of motion. Typically, the image substrate 14 carries two inter-leaved images but may equally carry more than two. The curvature of the lenses 16, which is typically semi-cylindrical, is determined in conventional manner to suit the number and nature of the images to be displayed.

In Figure 1, the viewer 18 can, for example, view the different images upon rotation or pivoting of the lenticular image 10 about an axis A-A as indicated by the arrow B, where the axis A-A runs substantially parallel with the longitudinal axis of the lenses 16. Similarly, lenticular images can be arranged so that the different images can be viewed by a viewer moving past the lenticular image.

Referring now to Figure 2, there is shown, generally indicated as 20, a display apparatus for lenticular images. The display apparatus 20 comprises a housing 22 which, in the preferred embodiment, comprises first and second frames 24, 26 each defining a respective

display window 28, 30. Preferably, a respective sheet of transparent material, e.g. plastics or glass, is provided in each display window 28, 30. The frames 24, 26 are operable between a closed state (shown in Figure 4) and an open state (shown in Figure 2). To this end, the frames 24, 26 are conveniently hinged to one another (see hinges 32) but may alternatively be interconnectable by other conventional means. Locking means (not shown) are preferably provided to maintain the housing 22 in the closed state. The frames 24, 26 may take any suitable shape but, most conveniently, are generally rectangular. The frames 24, 26 are preferably formed from a rigid material, e.g. aluminium or plastics. It will be understood that both frames 24, 26, need not necessarily define a display window - only the frame which, in use, exposes the lenticular image need define a display window.

The housing 22 is arranged to house a lenticular image assembly as illustrated in Figure 3. Figure 3 shows a preferred lenticular image assembly 34 comprising a lenticular, or lens, sheet 112, and an image sheet 114 sandwiched between first and second plates 140, 142. The lens sheet 112 comprises a plurality of lenses 116 and is generally similar to the lens sheet 12. The lens sheet 112 may be formed from any suitable transparent rigid or semi-rigid material, for example plastics. The image sheet 114 is generally similar to image sheet 14. However, the image sheet 14 and the lens sheet 112 are not fixed to one another and are therefore capable of relative sliding movement with

respect to one another. In Figure 3, the lens sheet 112 and image sheet 114 adopt a close or intimate facing relationship with one another. The lens sheet 112 and image sheet 114 may be in direct contact with one another, i.e. direct facing engagement, or they may be separated by an intermediate transparent sheet (not shown) to facilitate relative sliding movement between the two. Any such intermediate sheet must be sufficiently thin so as not to be significantly detrimental to image quality. Alternatively, other lubricating means may be provided between the image sheet 114 and the lens sheet 112. The image sheet 112 may be laminated between transparent plastics layers (not illustrated).

The plates 140, 142 are formed from rigid or semi-rigid material such as glass or plastics. The first plate 140 which, during use, is located against the ribbed face of the lens sheet 112 (i.e. the face that is viewed by a viewer) is formed from transparent material. In cases where the lenticular image 112, 114 is to be backlit, the second plate 142 is also formed from transparent material. Material marketed under the name Perspex (a transparent thermoplastic acrylic resin) or Lexan (a polycarbonate material) are suitable, as is glass. In cases where no backlighting is required, the second plate 142 may be formed from opaque material or may be omitted to reduce cost in which case the image sheet 114 comprises rigid or semi-rigid material, e.g. card.

The lens sheet 112 carried one or more lugs 144. In the illustrated embodiment, the lens sheet 112 comprises two spaced apart lugs 144 projecting from one side of the lens sheet 112 such that the lugs 144 are substantially coplanar with the lens sheet 112.

The lens sheet 112, image sheet 114 and plates 140, 142 are each substantially rectangular in shape and are of similar size. Hence, the overall lenticular image assembly 34 is substantially rectangular in both transverse and longitudinal cross-section. The shape and size of the assembly 34 is such that it may be housed with the housing 22.

Referring now to Figure 4, the assembly 34 is shown housed within the housing 22, the housing 22 adopting the closed state. It will be seen that the housing 22 is arranged to grip the assembly 34 and so to apply pressure squeezing the assembly 34 together. To this end, the frames 24, 26 are shaped to define, together, a recess 25, when in the closed state, the recess 25 running around the periphery of the windows 28, 30. The recess 25 is shaped and dimensioned to receive the periphery of the lenticular image assembly 34. In order to ensure that the recess 25 applies a squeezing force, i.e. grips, the assembly 34, it is preferred that a flexible padding, e.g. of rubber, is provided around at least one side of the recess 25. In the illustrated embodiment, a second recess 27 is formed in one of the frames 26 such that the second recess 27 runs around the side wall 29 of the first recess 25. A

flexible, resilient padding component 31 is located in the second recess 27. The padding component 31 may for example take the form of a rubber ring. The arrangement is such that, when the assembly 34 is closed within the housing 22, the padding component 31 is compressed between the frame 26 and the assembly 34. This ensures that the assembly 34 is held within the housing 22 under pressure. The pressure is sufficient to maintain a close or intimate contact between the image sheet 114 and the reverse face of the lens sheet 112.

The housing 22 further includes locating means for interaction with the image sheet 114 to maintain the image sheet 114 in a fixed position within the housing 22. In the preferred embodiment, one frame 24 carries a locating pin 33 and the other frame 26 defines a corresponding pin-receiving recess 35 which receives a protruding portion of the pin 33 when the housing is closed. The image sheet 114 includes a corresponding pin-receiving aperture 39 formed adjacent one end 37 of the sheet 114. Conveniently, the recess 35 is shaped to accommodate the end 37 of the sheet 114. When the assembly 34 is properly located with the closed housing 22, the pin 33 passes through the aperture 39 thereby fixing the position of the image sheet 114 with respect to the housing 22.

Hence, with the housing 22 in the closed state as shown in Figure 4, the image sheet 114 adopts a fixed position. The plates 140, 142 (when present) are also

preferably fixed with respect to the housing 22. Conveniently, this is achieved by dimensioning the plates 140, 142 so that they substantially fill the recess 25. However, the lens sheet 112 is capable of sliding movement within the housing 22. In Figure 4, the direction of movement of the lens plate 112 is indicated by arrow A and is substantially perpendicular to the longitudinal axes of the lenses 116 on the lens sheet 112. Hence, the lens sheet 112 is smaller than the recess 25 at least in the direction of movement.

In a preferred embodiment, a slipper bearing (e.g. a strip of plastics), roller, ball bearings, or similar device, is provided between the lens sheet 112 and the, in use, lower side of the frame 24 in order to reduce wear on the lens sheet 112 and/or frame 24 that would otherwise be caused by sliding engagement between the two. By way of example, Figure 6 shows a slipper bearing 50 incorporating plurality of rollers 52.

By way of further example, Figure 7 shows the, in use, lower part of the frame 24 and lower part of the lens sheet 112 with a slipper bearing 50' inserted therebetween. The slipper bearing 50' comprises a strip of relatively hard wearing, low friction material, e.g. nylon. Also shown in Figure 7 is a tilt adjustment bar or plate 60 located between the lens sheet 112 and the lower side of the frame 24. A pair of adjustment screws 62 are threaded into the adjustment plate 60. The screws 62 pass through the lower side of the frame 24 and are fixed relative to

frame 24 such that they may rotate about their respective longitudinal axis but are substantially unable to move in a direction parallel with their longitudinal axis. Hence, upon rotation of one or both of the screws, the lens sheet 112 may be tilted under the action of the tilt plate 60 about an axis substantially perpendicular to the plane in which the lens sheet 112 lies. Tilt adjustment may be used, if necessary, in aligning the lens sheet 112 and image sheet 114.

Also shown in Figure 4 is a hook 41 which may be used to hang the housing 22 on a wall during use, or to locate the housing 22 within a conventional advertising display apparatus such as a lightbox (not shown).

As may be seen from Figure 2, the housing 22 defines a respective aperture to allow each lug 144 of the lens sheet 112 to protrude from the housing 22. The protruding lugs 144 may be used to actuate the lens sheet 112 within the housing 22. Figure 5 shows an example of a suitable mechanism for actuating the lens sheet 112. The actuating mechanism comprises a cam 200 and preferably two cam followers 202. The cam followers 202 are coupled to a respective lever 204 (only one shown), one for each lug 144, each lever 204 being capable of pivoting oscillatory movement (as indicated by arrow B) about a pivot point P. In the preferred embodiment, the location of pivot point P with respect to the lever 204 is adjustable. In Figure 5, a plurality of alternative pivot points P' are shown

in broken outline. The pivot points P, P, may be provided in any convenient manner- for example, respective apertures may be formed in the lever 204 and in the housing 201 of the actuating mechanism such that a pivot pin (not shown) may be inserted through a selected aperture in the lever 204 and a corresponding aperture in the housing 201.

In use, any one of the pivot points P, P′ may be selected as the actual pivot point P of the lever 204. The closer the selected pivot point P is to the end 205 of the lever 204, the greater the leverage that may be exerted on the lens sheet 112 but the smaller the extent of the reciprocating movement imparted to the lens sheet 112 by the lever 204. Preferably, the spacing between selectable pivot points P, P′ corresponds with the width of the lens 116 on the lens sheet 112 (or a multiple thereof) such that the amount by which the lens sheet 112 moves in any one direction is substantially equal to one lens width or a multiple of one lens width, depending on which pivot point P, P′ is chosen. This ensures that the lens sheet 112 and image sheet 114 are kept substantially in register with one another irrespective of which pivot point is chosen. Hence, by selecting a suitable pivot point P, P′, the user is able to select how far he wishes the lens sheet 112 to travel with respect to the image sheet 114.

Each lug 144 carries two locating pins 206 between which the end 205 of the respective lever 204 is

located. An electric motor (not shown) is provided for driving the cam 200.

As the cam 200 rotates, the cam followers 202 impart oscillatory pivoting movement to each lever 204. Each lever 204 imparts reciprocating movement to the lens sheet 112 (as indicated by arrow A) via the locating pins 206 on the lugs 144. Reciprocating movement of the lens sheet 112 causes each image of the lenticular image to be displayed in turn.

The position of locating pins 206 on the lug 144 are preferably adjustable in a direction substantially perpendicular with the direction of movement of the lens sheet 112. To this end, in the embodiment of Figure 5, each pin 206 is slidable within a respective slot 207 and may be fixed at any position within the slot. By adjusting the position of the pins 206, the reciprocating movement of the lens plate 112 can be adjusted. More specifically, this allows relatively fine adjustment of the relative position of the image sheet 112 with respect to the image sheet 114 and may be used to ensure that the lens sheet 112 and the image sheet 114 are correctly aligned with one another.

Preferably, the cam 200 is a constant rate rise and fall cam i.e. the profile of the cam 200 is arranged so that the resultant reciprocating movement of the lens sheet 112 has a constant rate in both directions.

In the preferred embodiment, the image strips are carried on a transparent film made of a transparent material such as Perspex (Trade Mark) or Duratrans (Trade Mark). The typical thickness of the film may be between 0.007 thousandths of an inch up to 3 mm. In cases where the image sheet 114 comprises card, the card may typically be in the region of 1 mm thick. It will be appreciated that different thicknesses may alternatively be used although it is preferable to have the image sheet 114 relatively thin in order to reduce the costs of producing the image sheet 114.

By way of a typical example, for a housing 22 arranged to display lenticular images of approximately A1 paper size, the plates 140, 142 may be approximately 2mm in thickness while, for images of "six sheet" size(1200 mm wide x 1800 mm high), the thickness of the plates 140, 142 may be approximately 4 mm.

The cam 200 and lever 204 assembly may for example be arranged to provide a 5 to 1 ratio of leverage. The adjustable pins 206 may, for example, allow this ratio to be adjusted between, for example, 5.2 and 0.8.

The constant rate rise and fall of the cam 200 may be arranged to provide a lift of the lens sheet 112 within the range 7 mm to 23 mm (typically for A1 or six sheets display).

Varying speeds of reciprocation of the lens sheet 112 can be achieved by changing the cam lift so that the

lenses 116 undergo smaller or larger movements with respect to the image sheet per revolution of the cam.

The apparatus 20 may be used with image sheets carrying either a plurality of interleaved static images or a plurality of interleaved images which, when viewed in sequence, give the impression of animated movement. The actuating mechanism, and in particular the speed rotation of the cam 200 and the location of the selected pivot point P, may be readily adjusted to suit the intended use. It is preferred to use image sheets which give the impression of animated movement since the animated sequence may be viewed "head on", i.e. from a line of sight perpendicular to the plane of the lens sheet/image sheet, as well as from lines of sight that are oblique with respect to the plane of the lens sheet/image sheet.

It will be appreciated from the foregoing that the apparatus of the invention provides a relatively simple device for displaying lenticular images and may be particularly attractive to advertisers who use existing advertising lightboxes since the apparatus of the invention may readily be incorporated into existing lightboxes.

Moreover, because the lens sheet is not permanently fixed to the image sheet, the lens sheet 112 is effectively reusable - only the image sheet 114 needs to be discarded when the image becomes redundant. Further, because the image sheet 114 remains static

within the housing 22, it does not need to be formed from a rigid or heavy-duty material. Rather, it may be formed from a thin film of plastics or paper. Hence, the disposable part of the apparatus, i.e. the image sheet, is relatively inexpensive.

By way of further illustration, Figure 8 shows a side section view of an apparatus embodying the invention which is generally similar to the apparatus illustrated and described in Figures 2 to 7 and on which corresponding reference numerals are used. Figure 8 shows the cam 200 and a motor 300 arranged to actuate a cam 200 in order to impart a reciprocating motion to the lens sheet 112 in the general direction indicated by arrow A.

The apparatus 20 shown in Figure 8 shows that the lens sheet 112 includes one or more second lugs 145 oppositely disposed on the lens sheet 112 to lugs 144. The frames 24, 26 are shaped to accommodate the lugs 145 when closed together. The second lugs 145, in conjunction with the passage formed between the frames 24, 26 to receive the lugs 145, serves to guide the lens sheet 112 as it moves back and forth during use.

It will be noted from Figure 8 that the motors 300 and actuating mechanism coupled thereto are located at or adjacent the lugs 144 at one side of the apparatus 20. Bearing in mind that, in some modes of use, the apparatus 20 is inserted into an existing light box (not shown), it is not always practical to have the

motors 30C and associated actuating mechanism located at one side of the apparatus 20 as there may not be sufficient room in the light box.

Figure 9 shows an alternative embodiment in which the motor 300 and the actuating mechanism are located at the, in use, rear of the apparatus 920, i.e. behind the lenticular image assembly 934. In Figure 9, the apparatus 920 is generally similar to the apparatus 20 shown in Figures 1 to 8 and like numerals are used to indicate like parts. It will be noted however that the lenticular image assembly 934 does not, for the purposes of illustration only, include a first plate against the obverse face (i.e. the face that carries the lenses 916 of the lens sheet 912). In general, the first plate 140 is an optional component of the lenticular image assembly 34, 934.

In the embodiment of Figure 9, at least one of the lugs 944, 945 carries a respective arm 947, 949 extending substantially perpendicularly from the lens sheet 912. The actuating mechanism includes a rotatable cam 200 coupled to the motor 300 for rotation, in use, in a plane substantially parallel with the plane in which the lens sheet 912 is disposed. The cam 200 carries a cam rod 203 which rotates with the cam 200. A respective linkage lever 204, 204' is coupled to the cam rod 203 and to a respective one of the arms 949, 947. The arrangement is such that, upon rotation of the cam 200, the levers 204, 204' impart reciprocating, or oscillatory movement to the lens sheet 912 via arms

949, 947. To this end, it is preferred that the respective ends 205, 205′ of the levers 204, 204′ carry a respective two, spaced apart locating pins 207, 207′ arranged to receive the respective arm, 949, 947 therebetween. The locating pins 207, 207′ preferably extend substantially perpendicularly from the levers 204, 204′ and substantially parallel with the arms 949, 947. The non-fixed inter-engagement of the arms 949, 947 and respective pins 207, 207′ provide a non-rigid coupling between the lens sheet 912 and the levers 204, 204′.

Mounting the motor 300 and actuating mechanism 200, 203, 204, 205′ at the rear of the apparatus 920 is particularly useful in situations where the apparatus 920 is to be inserted into a light box that does not offer sufficient room at its sides.

Preferably, the lens sheet 912 has a single lug 944, 945 on two opposing sides (see Figure 11) which are preferably substantially centrally located on the respective sides as shown in Figure 11. In such an embodiment, the motor 300 and cam 200 are conveniently substantially centrally located with respect to the lens sheet 912. In an alternative embodiment, the lugs 944, 945 need not be centrally located on their respective sides of the lens sheet 912. Moreover, the actuating mechanism may only comprise one lever 204 coupled to one side of the lens sheet 912 only.

Figure 10 illustrates a further embodiment of the invention in which the slipper bearing 50, 50' is replaced by one or more cams 70, 71 (two shown), each cam 70, 71 serving as, or carrying a bearing (e.g. a ball bearing). In Figure 10, the apparatus 1020 is shown with a respective two lugs 1144, 1145 on two opposite sides of the lens sheet 1112. The cams, 70, 71 are associated with the respective lug 114, 115 on either side of the lens sheet 1112 and are eccentrically mounted on the apparatus 1020 for rotation with respect to lugs 1144, 1145. The arrangement is such that each cam 70, 71 (or the bearing associated therewith) engages with the respective lug 1144, 1145 so that, upon rotation of the cams 70, 71, the lugs 1144, 1145, and therefore the lens sheet 1112, are moved up or down in the direction indicated by arrows C, depending on the angular position of cams 70, 71.

Figure 11 illustrates a further embodiment in which the lens sheet 2112 has a single lug 2144, 2145 on two opposing sides, each lug 2144, 2145 preferably being centrally located on its respective side. Each lug 2144, 2145 is associated with a cam 2070, 2071 in a substantially similar manner to that described for the cams 70, 71 of Figure 10. Figure 7 also shows the actuating mechanism including the cam 2200 and lever 2204 connected to the lug 2144 for imparting reciprocating movement to the lens sheet 2112 in the direction of the arrow A.

A still further embodiment of a display apparatus 3020 is presented in Figures 12 to 16. The display apparatus 3020 may be generally similar to the apparatus of previously described embodiments, except that the drive mechanism 3117 is located adjacent a side 3123 of the lens sheet 3116 that is generally parallel with the direction of movement of the lens sheet 3116 (as indicated by arrow A). This is in contrast to the embodiment of Figures 1 to 7 in which the drive mechanism is located adjacent a side of the lens sheet 116 that is generally perpendicular to the direction of movement of the lens sheet 116. In use, this usually means that the drive mechanism 3117 is located at the upper side or lower side of the display apparatus 3020. The apparatus 3020 is particularly suitable for use with light boxes (not shown) or other display equipment in which there is limited space at the, in use, vertical sides of the equipment or in which there is restricted depth.

Referring now to Figures 12 to 16, only part of the display apparatus 3020 is shown (the non-illustrated parts of apparatus 3020 may be generally similar to one or more of the previously described embodiments). The lens sheet 3116 includes two spaced apart lugs 3144 which preferably project beyond the frame 3014 and are preferably located at or adjacent opposite sides of the lens sheet 3116. A respective bearing slot 3121 is formed in each lug 3144, the slots 3144 extending in a direction substantially parallel with the desired direction of movement of the lens sheet (as indicated

by arrow A). A respective support bearing 3119 is located in each bearing slot 3121. Preferably, each support bearing 3119 comprises a roller bearing. The support bearings 3119 may be fixed with respect to the apparatus 3020 by any suitable means. For example, with reference to Figures 14 and 15, one or more support brackets 3125 may be fixed to the frame 3124 and arranged to carry the support bearings 3119. Preferably, the location of one or both support bearings 3119 is adjustable in a direction generally perpendicular with the direction A. This may be achieved in any convenient manner. For example, each bearing 3119 may be mounted on a respective cam 3127 (only one shown), each cam being eccentrically mounted on a bracket 3125. By rotating the respective cam the respective bearing 3119 is moved up or down (as viewed in figures 12 to 16). This allows the orientation of the lens sheet 3116 to undergo tilt adjustment as described with reference to Figures 10 and 11.

As may best be seen from Figure 14, it is preferred that a rigid plate 3131, e.g. of metal, is fixed to each lug 3114 to provide rigidity and reinforcement.

The drive mechanism 3117 comprises a cam 3200 rotatably mounted, and preferably eccentrically mounted, on the frame 3124 (e.g. via bracket 3125). The arrangement is such that the cam 3200 is located between the lugs 3144, preferably substantially at the midpoint between the lugs 3144. In use, the cam 3200 is driven by a rotary motor (not shown) which may also be mounted on

the bracket 3215. A respective lever 3204 is connected between the cam 3200 and the respective lugs 3144. In the preferred embodiment, each lever 3204 has one end pivotably mounted to a common connection point 3133 which is off-centred on the cam 3200. The respective other end of each lever 3204 is pivotably mounted to a respective lug 3144. In use, rotational movement of the cam 3200 causes levers 3204 to impart reciprocating movement to the lens sheet 3116 in the direction indicated by arrow A. The movement of the lens sheet 3116 is guided by the sliding engagement between the slots 3121 and the respective bearings 3119. The provision of rollers 3135 on the bearings 3119 helps to ensure smooth movement of the lens sheet 3116.

The extent of the reciprocating movememt of the lens sheet 3116 is determined by the location of the common connection point 3133 on the cam 3200. In the preferred embodiment, the levers 3204 may be connected to one of a plurality of connection points, each connection point being located at a respective different distance from the centre of the cam 3200. This allows the extent of movement, or travel, of the lens sheet 3116 to be adjusted.

Figure 16 shows an end view of the apparatus 3020 and illustrates the lens sheet 3116, the image sheet 3114, backing plate 3142, padding/pressure component 3031 and frames 3024, 3026, all being generally similar arrangement to the previously described embodiments.

It will be seen that the frames 3024 is arranged to provide a gap 3137 to allow movement of the lens sheet 3116 in direction A.

The invention is not limited to the embodiments described herein which may be modified or varied with departing from the scope of the invention.

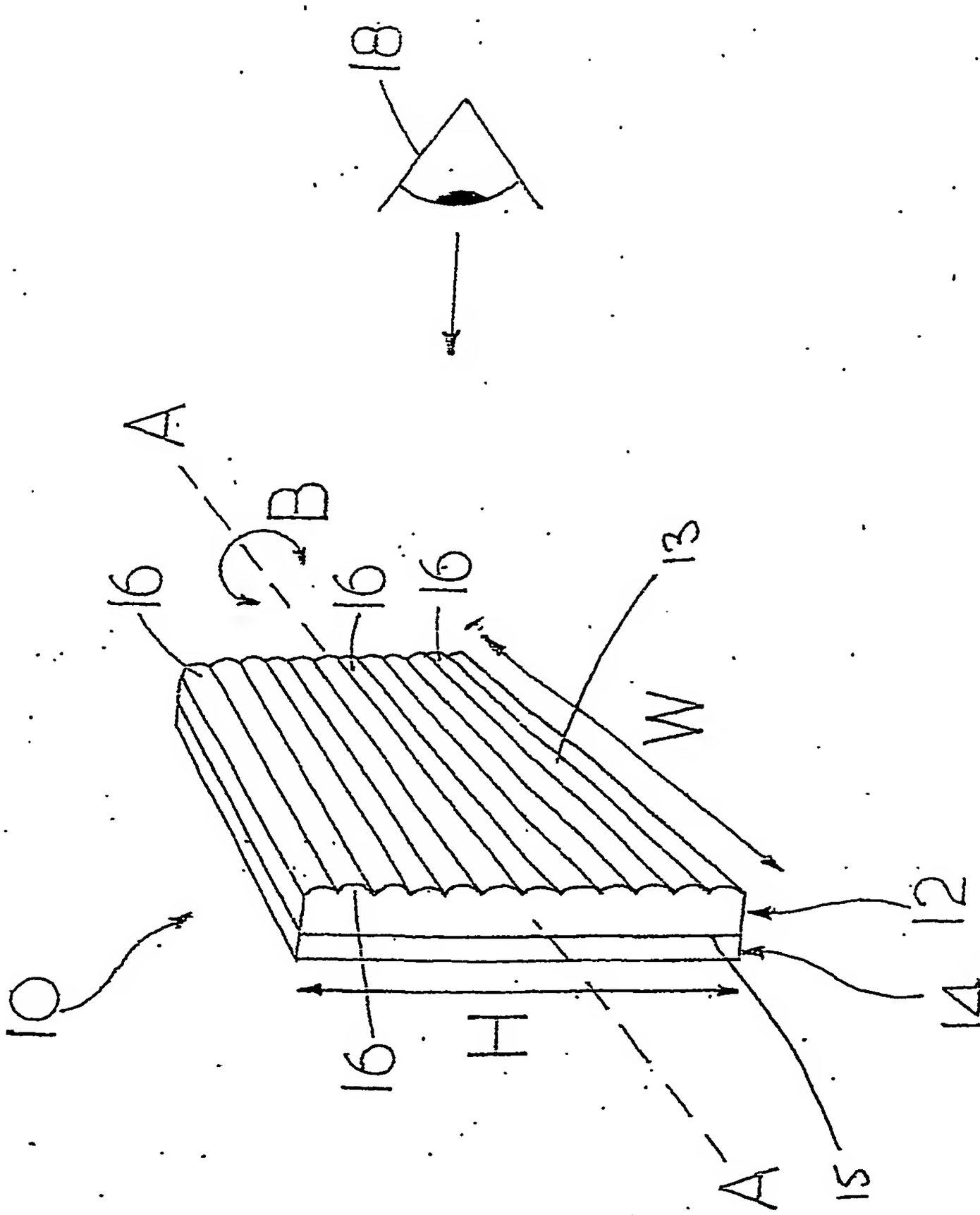

FIG 1

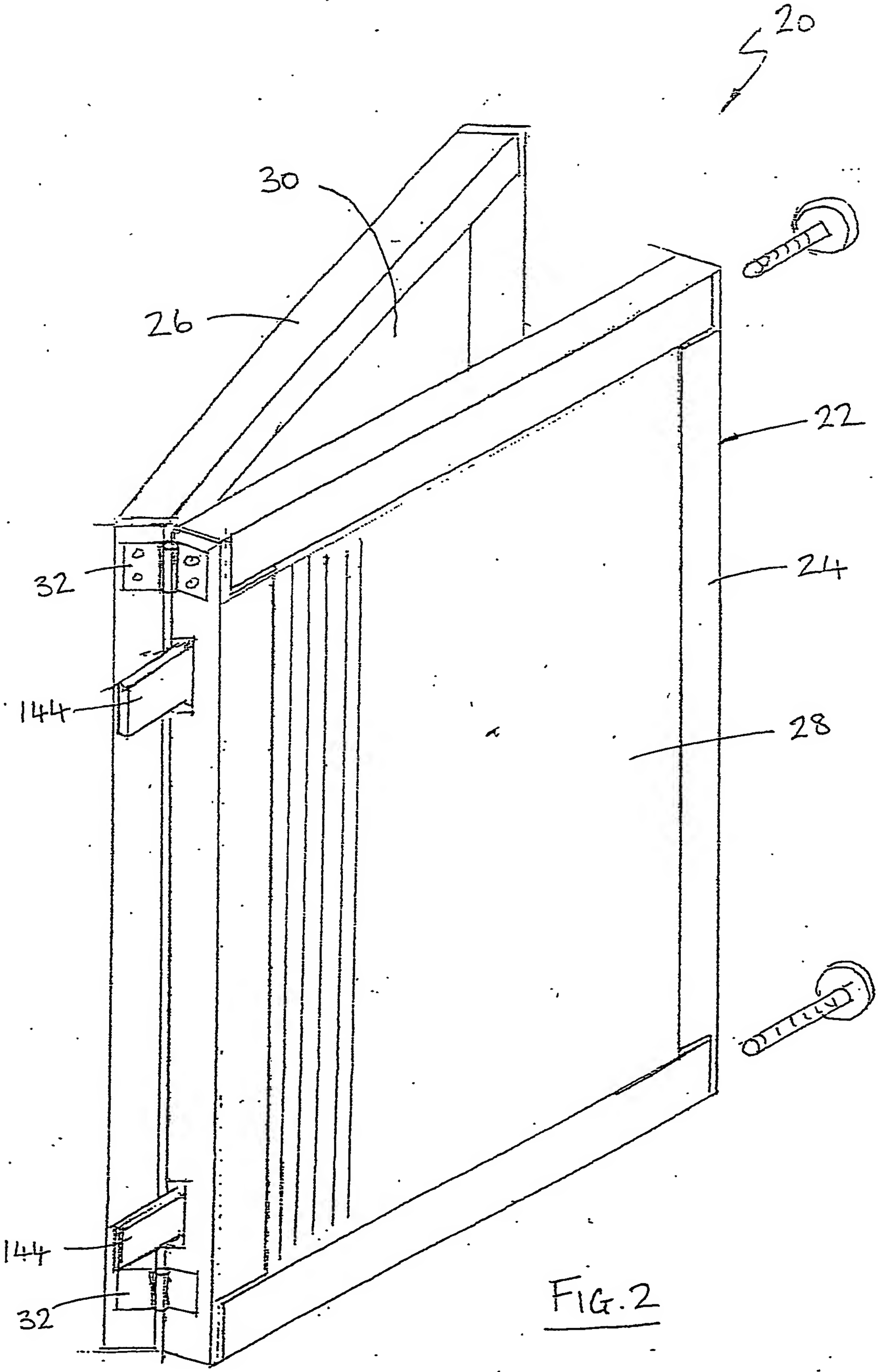

FIG. 2

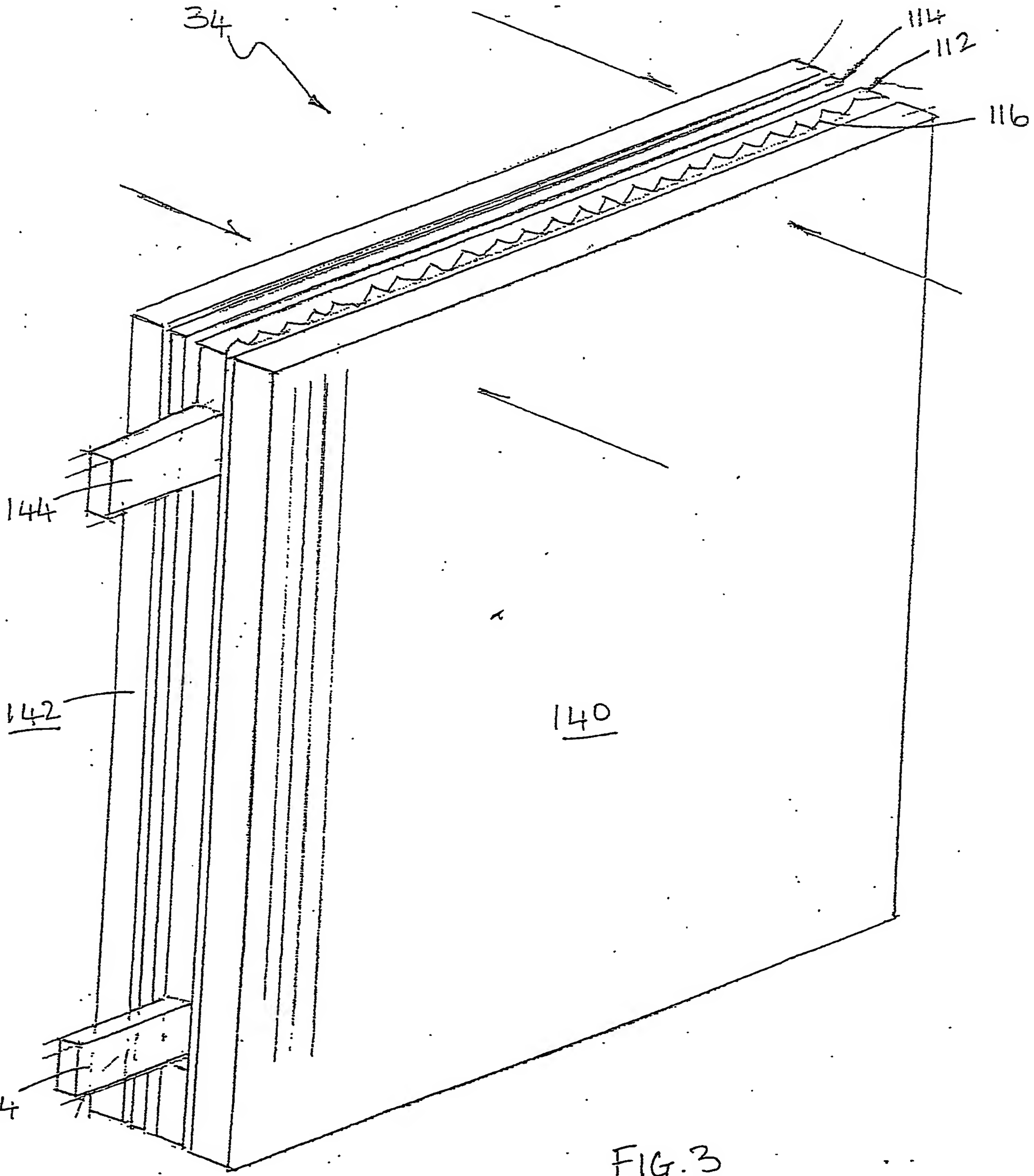

FIG. 3

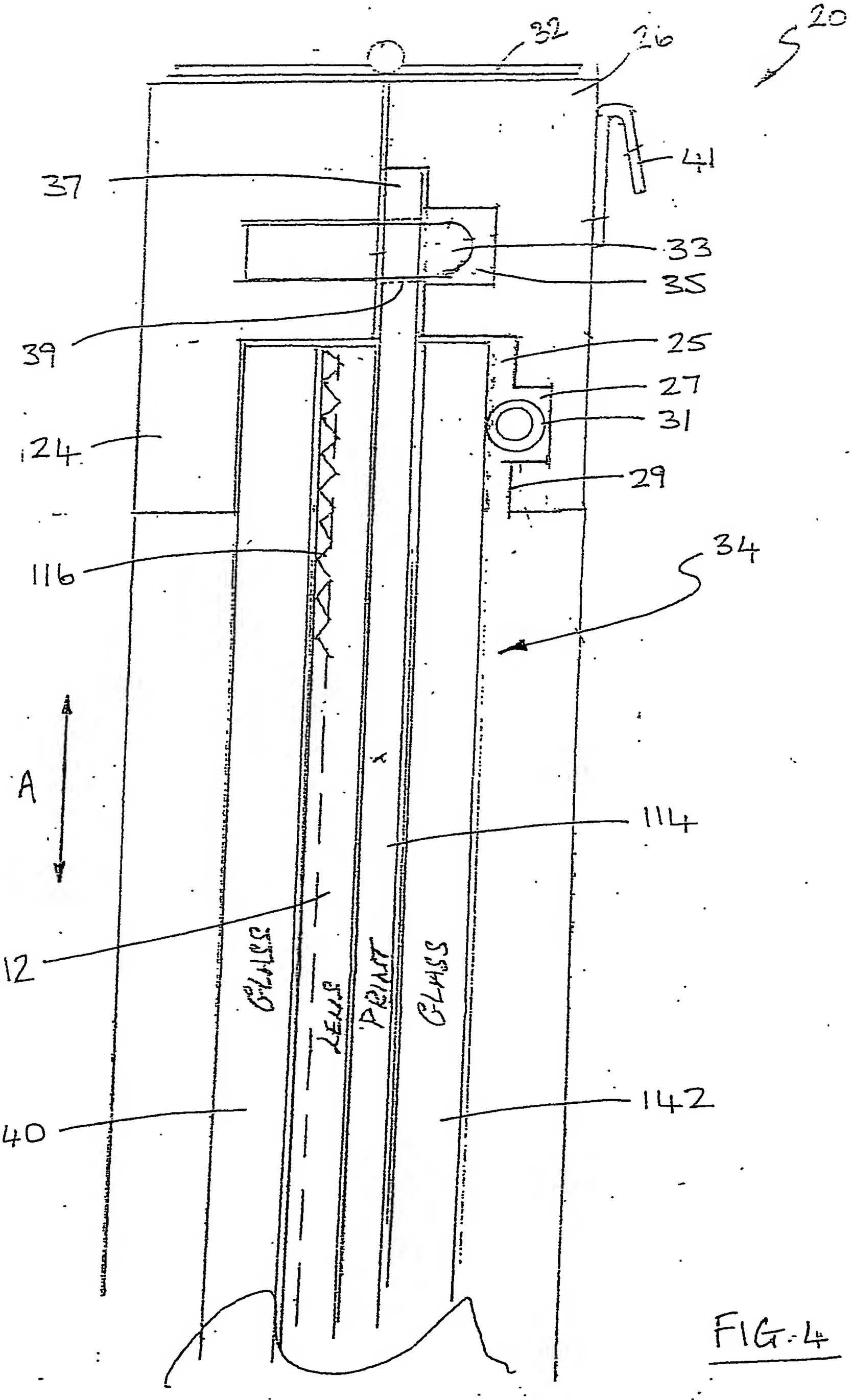
32
26
20
41
37
33
35
39
25
27
31
124
29
34
116
A
114
112
140
142
GLASS
LIQUID CRYSTAL
PLASMA
GLASS

FIG-4

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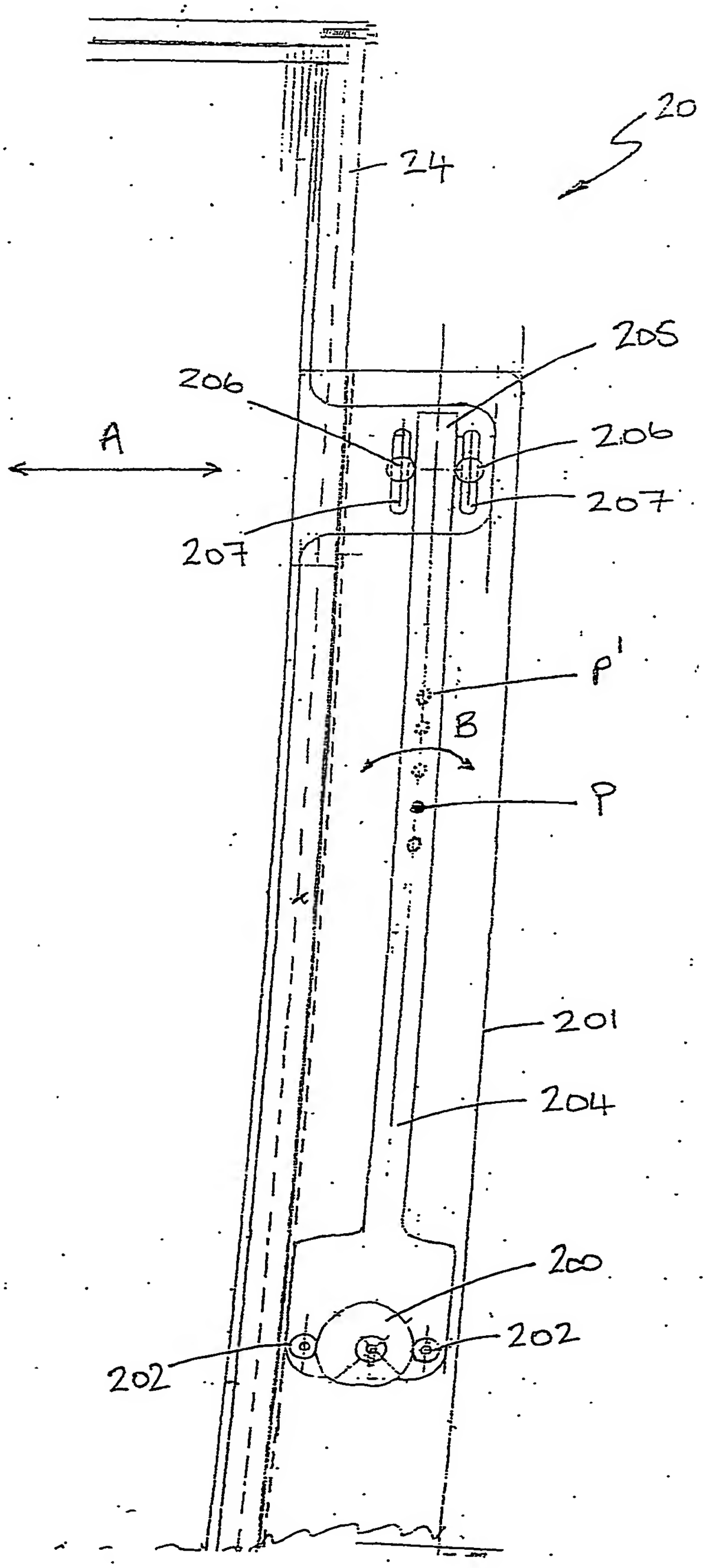

FIG. 5

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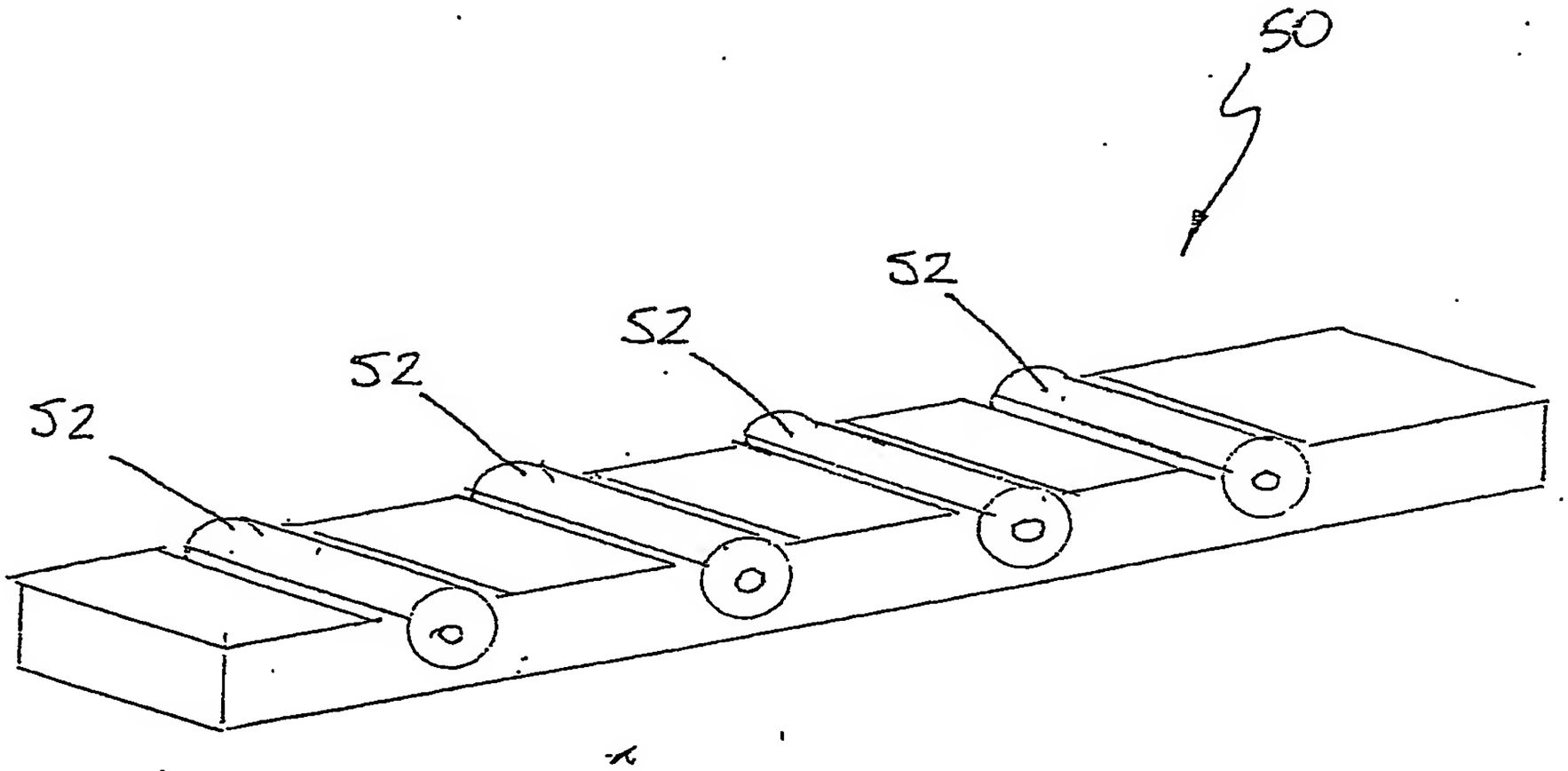

FIG. 6

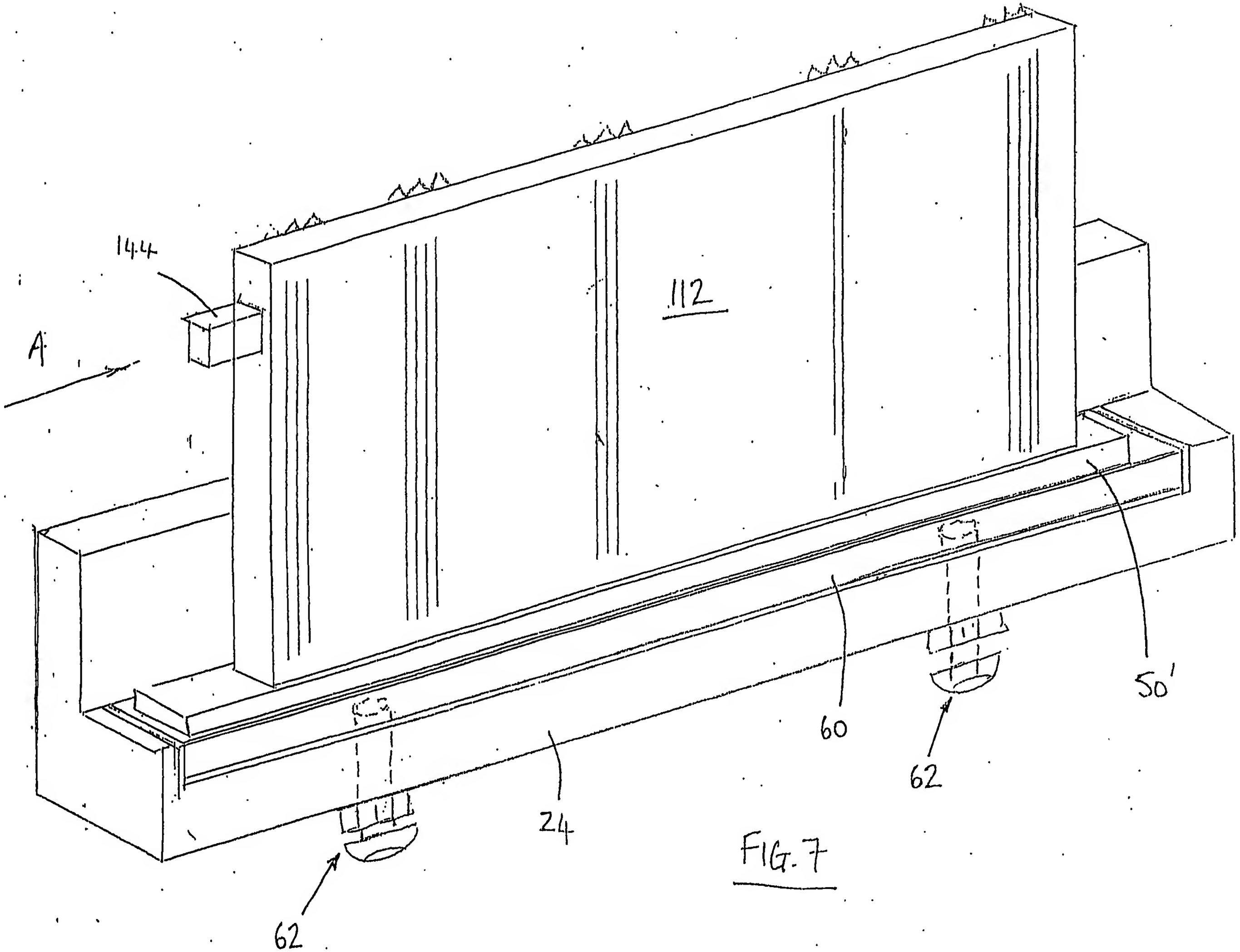

FIG. 7

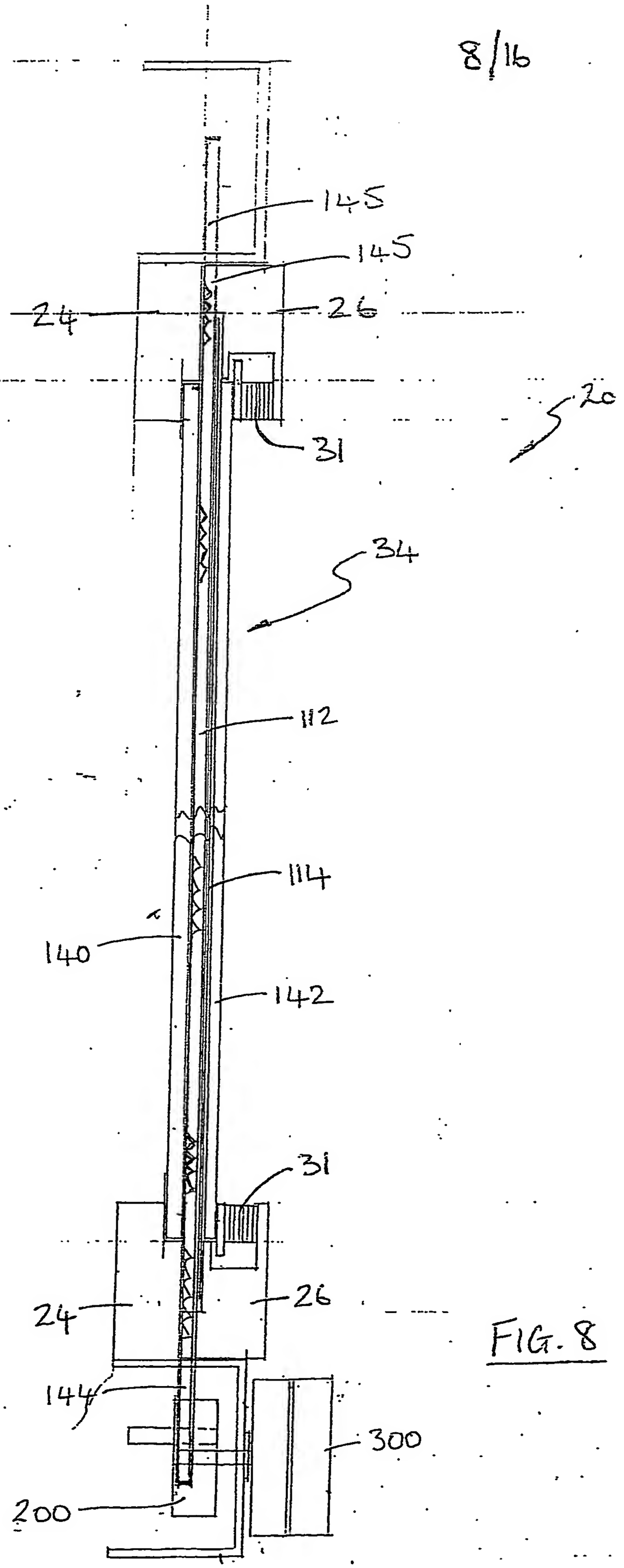

FIG. 8

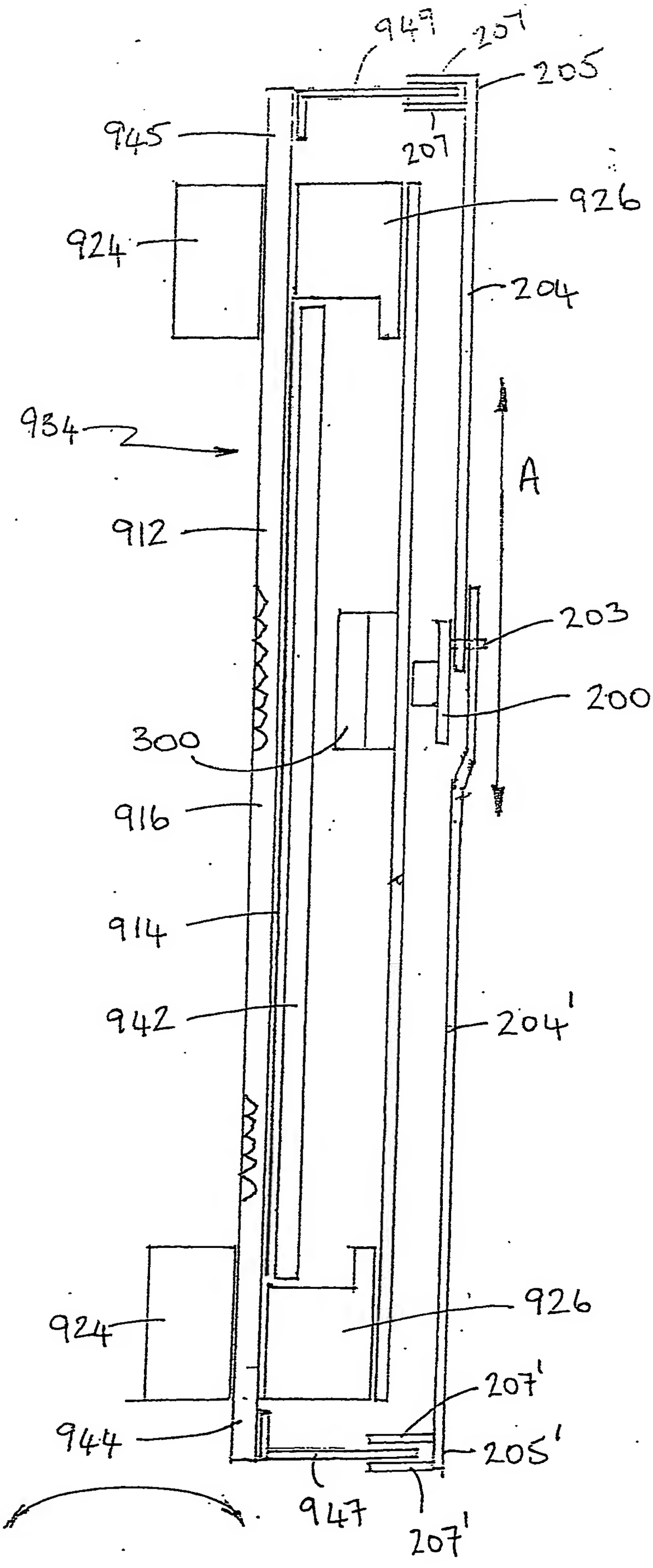
949
207
205
945
207
926
924
920
204
934
A
912
203
200
300
916
914
942
204'
924
926
207'
944
205'
947
207'

FIG. 9

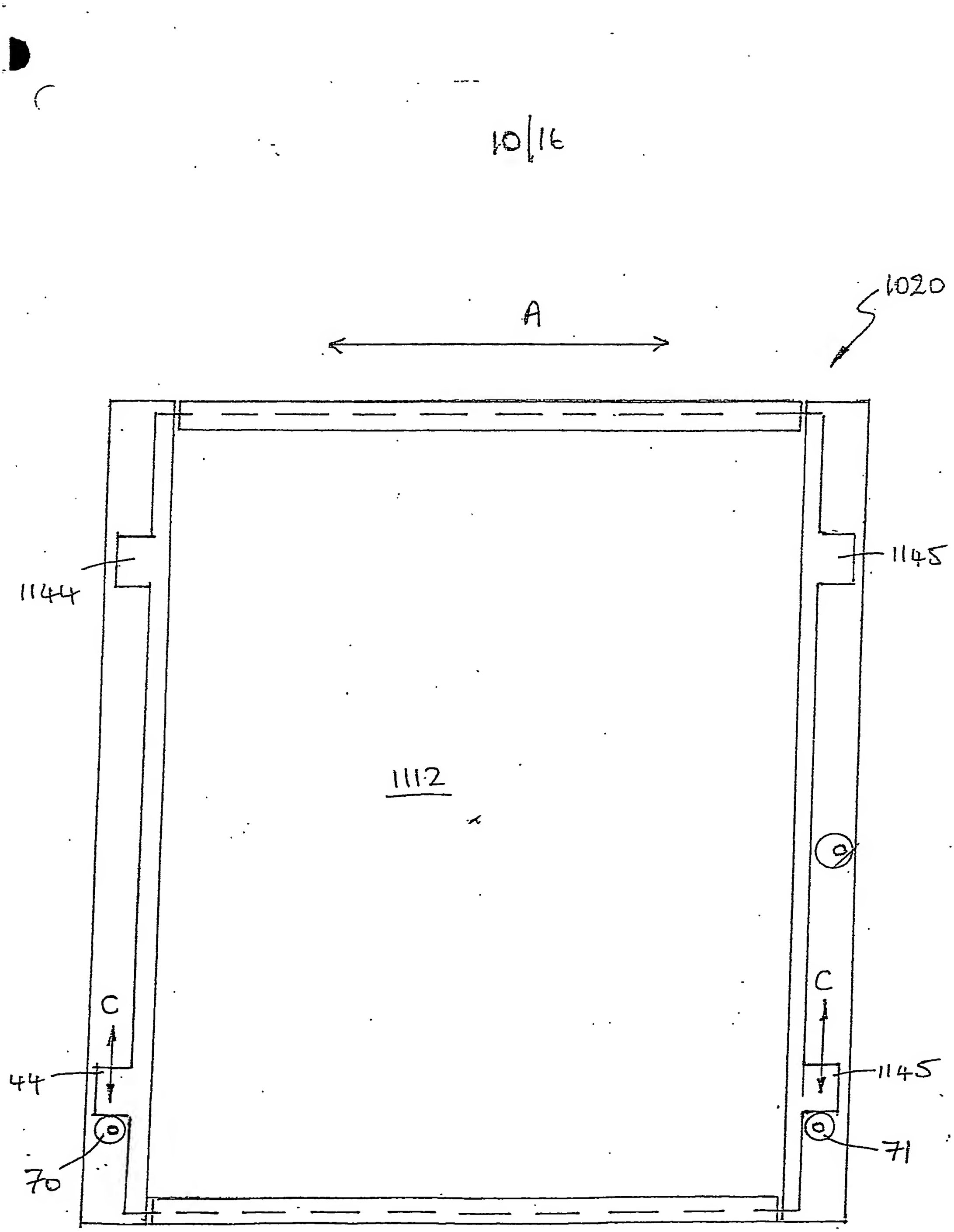

FIG. 10

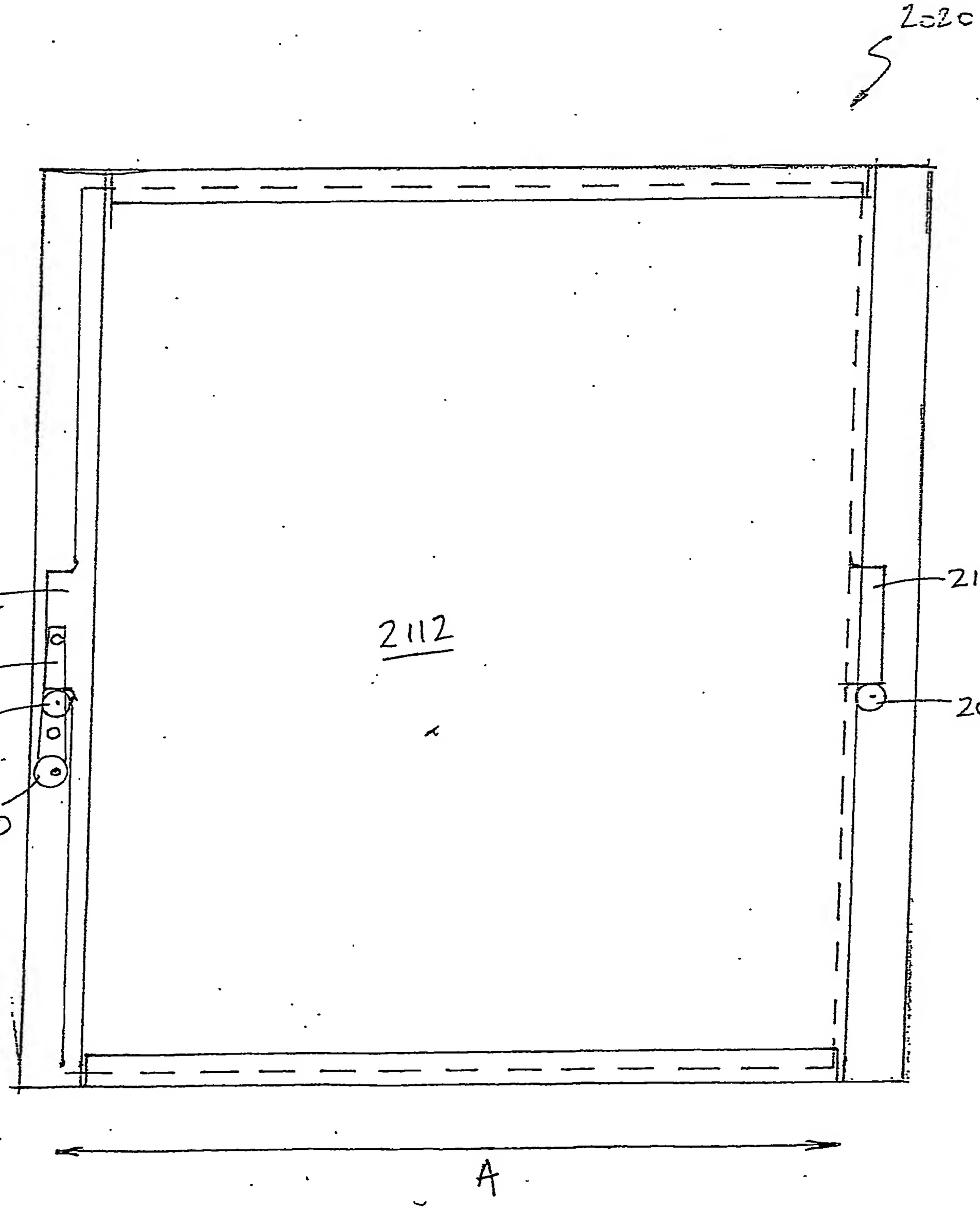

FIG. 11

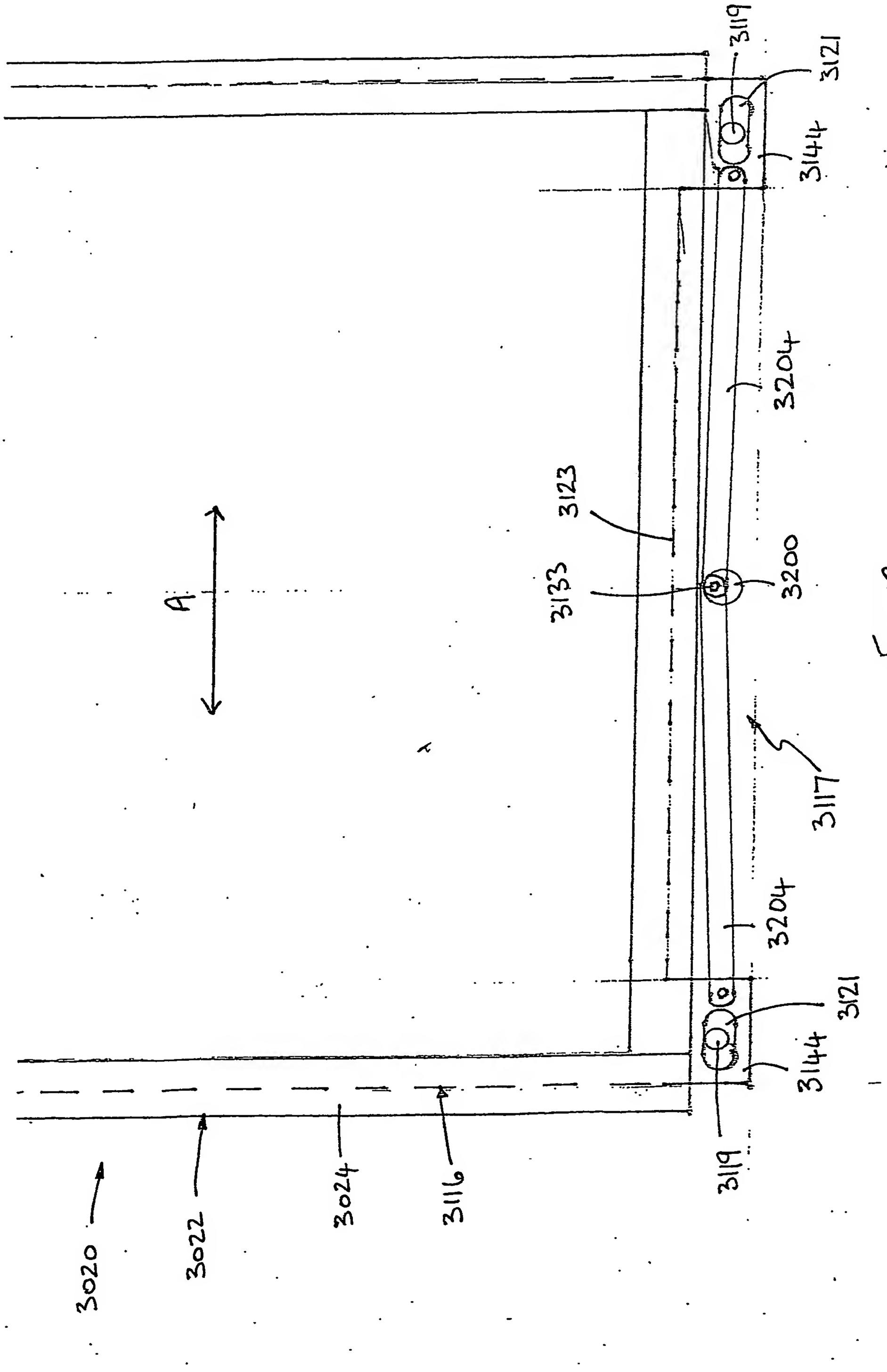
3119
3121
3144
3204
3123
3133
3200
3117
A
3020
3022
3024
3116
3119
3144
3121
3204

FIG. 12

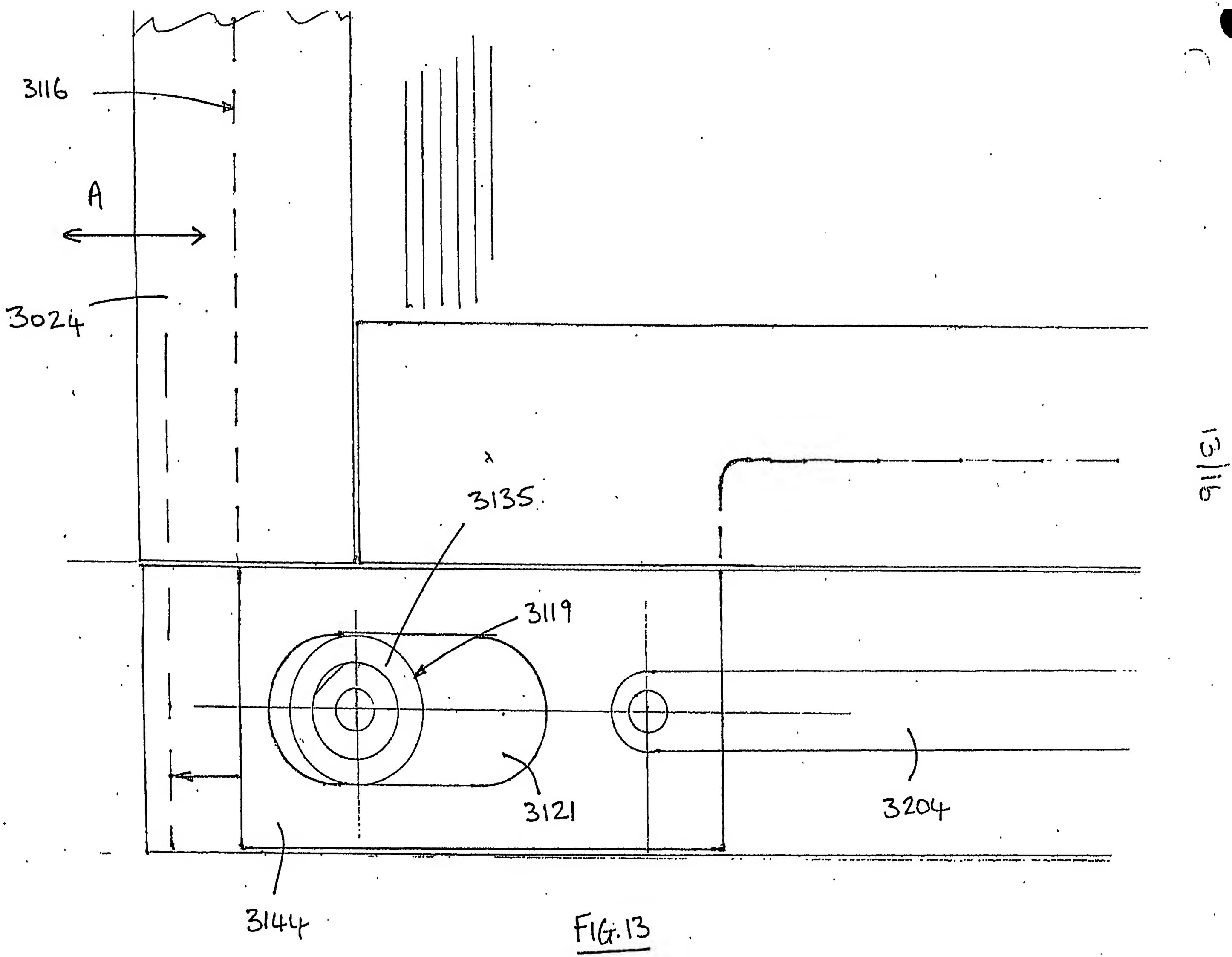

FIG. 13

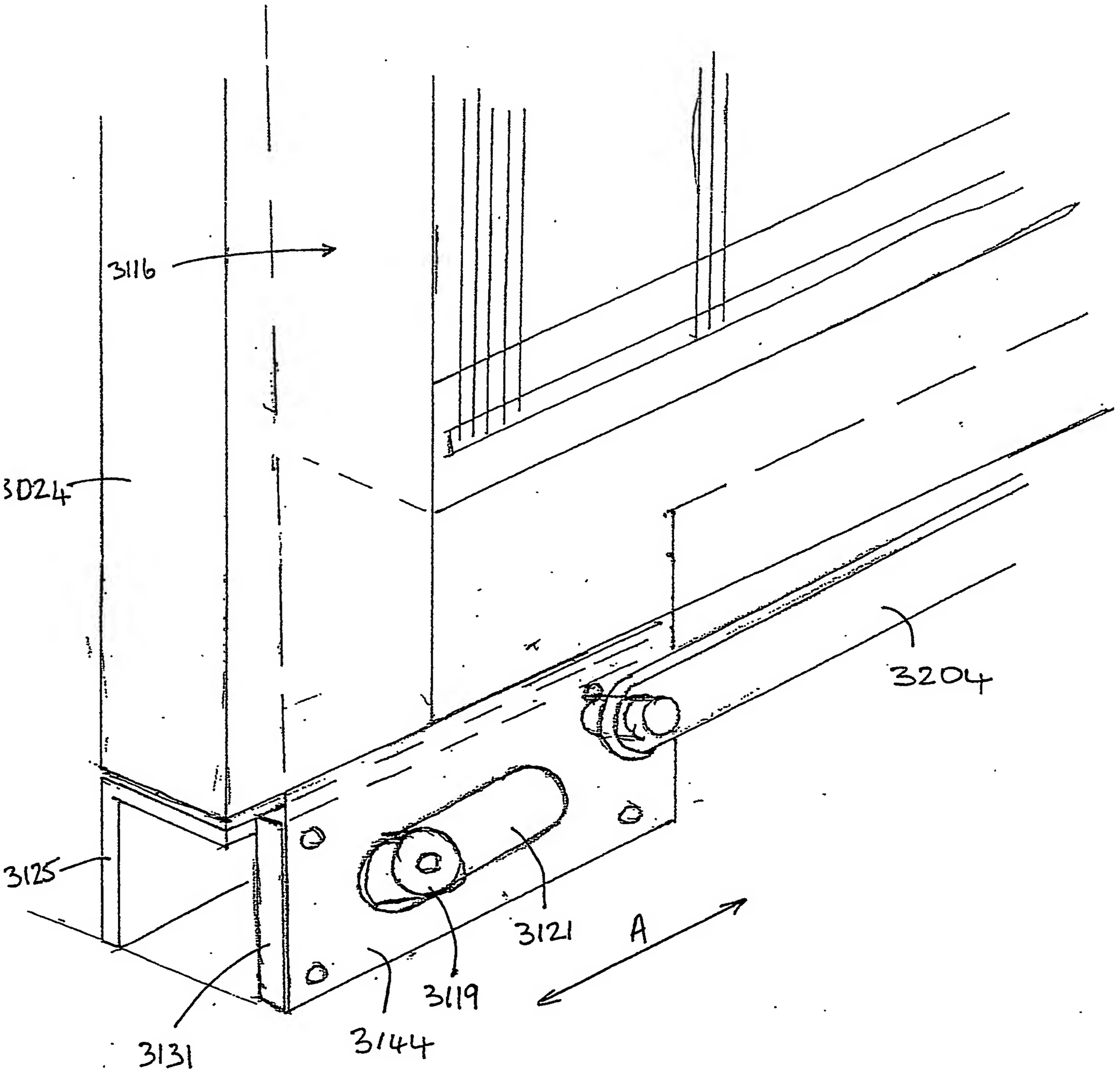

FIG. 14

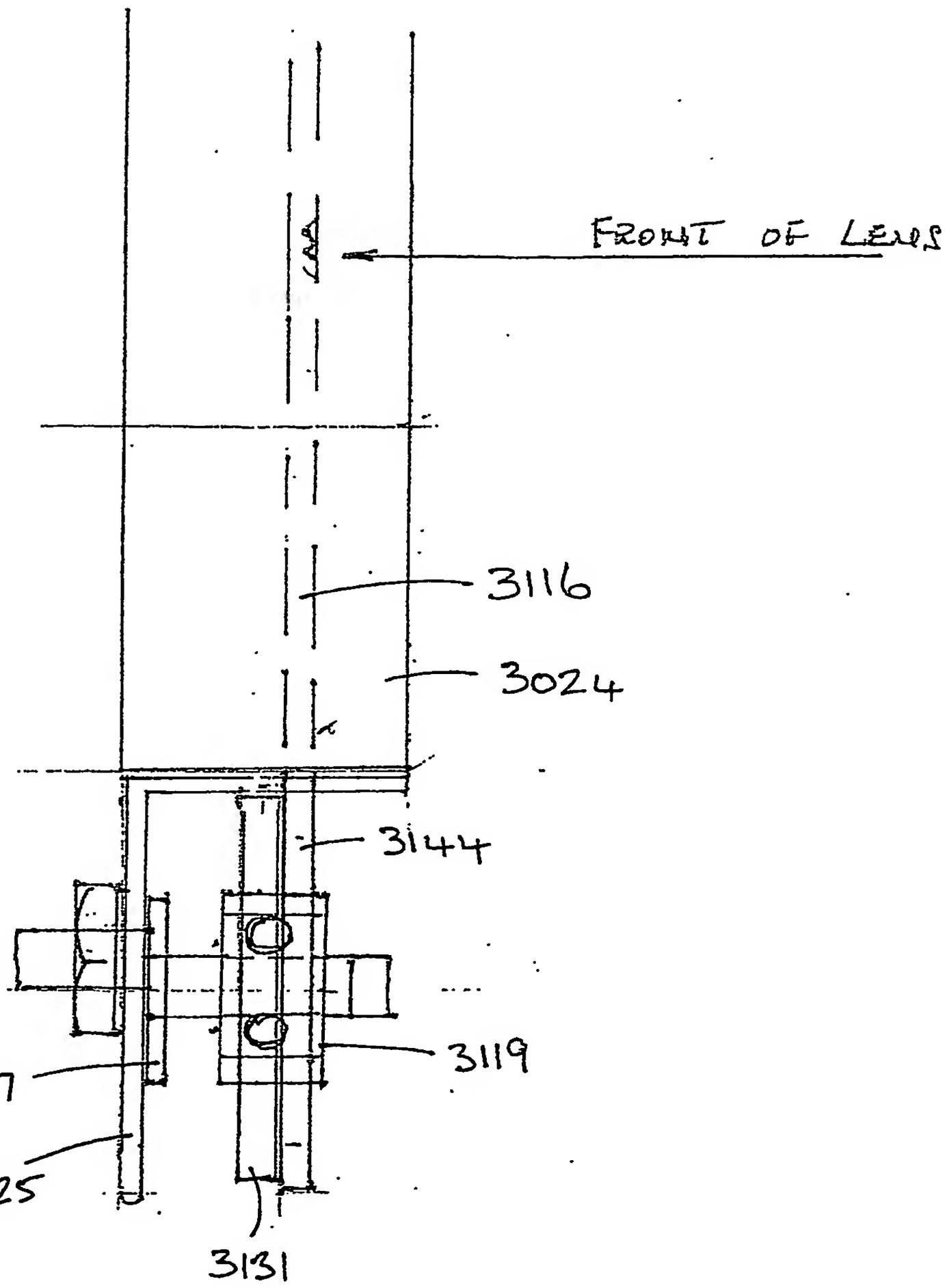

FIG. 15

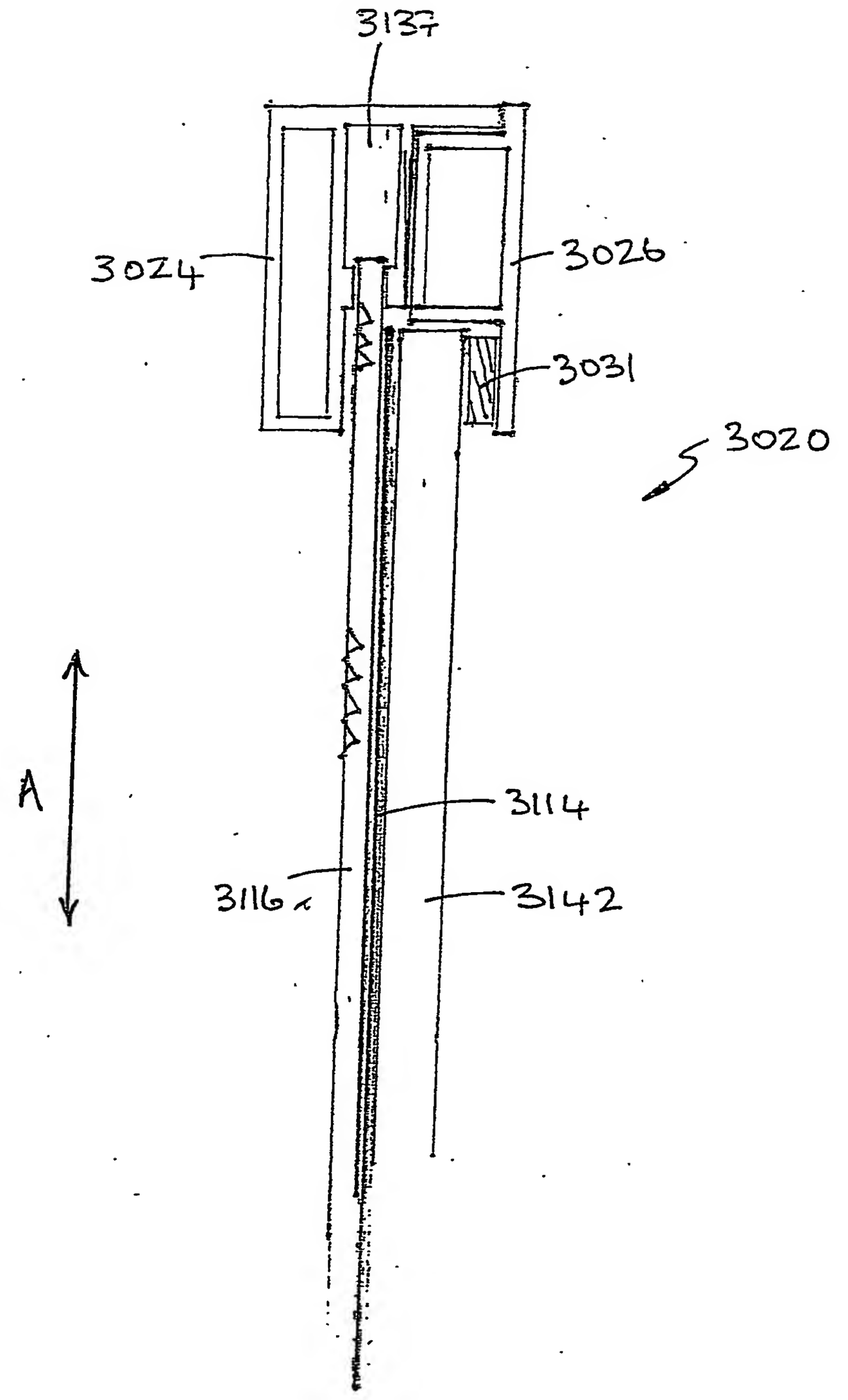

FIG. 16

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